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Lessons Learned from ET Design Process for ASAS/ENSCE

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This research note discusses the lessons learned from the application of existing embedded training (ET) design guidelines to an emerging system. The system to which the guidelines were applied was the All Source Analysis System/Enemy Situation Correlation Element (ASAS/ENSCE). The note presents the lessons learned from three phases of the project: task analysis, selection of ET requirements, and development of a training design concept. In addition to the lessons learned, recommendations for the modifications of the guidelines are presented.

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LESSONS LEARNED FROM ET DESIGN PROCESS FOR ASAS/ENSCE

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LESSONS LEARNED FROM ET DESIGN PROCESS FOR ASAS/ENSCE

INTRODUCTION

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Army's Project Manager Training Devices (PM TRADE) are responsible for a research and development program exploring the capabilities of Embedded Training (ET). Embedded training is defined as training that is provided by capabilities designed to be built into or added into operational systems to enhance and maintain the skill proficiency necessary to operate and maintain the equipment end item. The objectives of the program are the development and evaluation of procedures and guidelines for targeting ET needs and implementing ET.

This report is one in a series providing input into the development of ET procedures through application of guidelines for exemplar systems. This report covers the lessons learned obtained from application to the U.S. Army's All Source Analysis System (ASAS), and its Air Force equivalent, the Enemy Situation Correlation Element (ENSCE). The development of both systems is being performed under the auspices of the Joint Tactical Fusion Program Office (JTFPO). ASAS and ENSCE are Automated Information Systems (AISs) that will be used by Army and Air Force Military Intelligence (MI) personnel to integrate and disseminate collected information. ASAS/ENSCE will be fielded in several releases. The earlier releases will contain the bulk of the operator functions. Later releases will build upon this foundation, and will occur as Pre-Planned Product Improvements (P^3I).

ASAS/ENSCE was selected for examination for several reasons. First of all, as an AIS, it is a type of system for which ET is particularly potentially feasible and desirable. It is a computer-based system on which the training for the system may be delivered. Second, ASAS/ENSCE exhibits certain system characteristics that are not addressed in detail by the existing guidelines for the development of ET. These guidelines are: <u>A Procedure for Developing Embedded Training Requirements</u> (Roth, et al., 1986) and <u>Interim Procedures for Embedded Training (ET) Component Design</u> (Fitzpatrick, et al., 1987). The current versions of the guidelines are limited because they are based upon work done on systems further along in the development process and dominated by proceduralized, psychomotor tasks. ASAS/ENSCE, on the other hand, is a system that is in an earlier stage of development. Also, the tasks associated with ASAS/ENSCE have an important cognitive component in that the user is constantly making decisions concerning information access and use. Thus, ARI and PM TRADE felt that examination of a system such as ASAS/ENSCE, in light of the existing ET guidelines, could provide a basis for the expansion of those guidelines to earlier stages of development and to more cognitively based systems.

This document is the fourth in a series of four reports resulting from the application of ET guidelines for the determination of ET

requirements for ASAS/ENSCE, and the subsequent development of a design for ASAS/ENSCE embedded training. It should be more properly stated that most of the work for this effort has been focused on the ASAS component of the system, because of limitations on information availability for ENSCE. The first report generated for this project, entitled Preliminary Task Descriptions for ASAS/ENSCE (Evans, et al., 1987a), contained a collection of operator tasks for ASAS. These tasks included those for the six functional areas that will be represented in the target release for the system, as well as common user tasks that will also be supported by this release and two functional areas that will be supported by later releases. The second report, entitled, Preliminary Embedded Training Requirements (ETRs) for ASAS/ENSCE (Evans, et al., 1987b), was the result of the application of ET requirement selection procedures as presented by Roth, et al., 1986, with some modification to the ASAS tasks generated for the first document. The third report, Preliminary Embedded Training Design and Integration Concepts for ASAS/ENSCE (Evans, et al., 1987c), contained ET design guidance input for the ASAS/ENSCE training developers.

An original intent of this project was to use to the fullest extent possible the guidelines for ET design that are being developed by ARI and, through the use of the procedures outlined in the guidelines document, determine weaknesses in those procedures. The current document contains the lessons learned from the project as a whole and recommendations for modifications of the existing guidelines.

This document presents the methodology used for this project and the results of the project. There are two types of outcomes of this project: one is the actual products of the project, represented by the ASAS/ENSCE task analysis, the ASAS/ENSCE ETRs, and the ET design recommendations; the second type of outcome of the project is the set of lessons learned from the analytic process that was followed. In this report, the focus is on the second type of outcome and the implications for the ET guideline development process.

There are four sections to this document in addition to this Introduction. Each of the first three sections deal with one phase of the project. These three phases are as follows:

1. Task analysis.

2. The selection of ETRs.

3. The design of an ET component for the ASAS/ENSCE training system.

All three of these sections are similar in format. Each section contains a statement describing the task, a subsection on the methodology employed to perform the task, discussion of the lessons learned from performing the task, and any recommendations generated from the lessons learned. The final section of this document is a summary of the lessons learned that prevailed through all phases of the project.

ASAS/ENSCE TASK ANALYSIS

Statement of the Task

The initial task that was undertaken for this project was to develop a set of task descriptions for ASAS/ENSCE operator tasks. These tasks were limited to those performed on the Portable ASAS/ENSCE Workstation (PAWS) and covered the following areas:

1. System Supervisor (SS).

2. Collection Management (CM).

3. All Source Analysis (AS).

4. Target Analysis (TA).

5. Situation Analysis (SA).

6. Communications Intelligence (COMINT).

7. Electronic Intelligence (ELINT).

A list of Common User (CU) Tasks was also developed.

In addition to the steps in performing each task, information that was to be used in later phases of the project was also included for each task. This information included, but was not limited to: reference source of the task, equipment used to perform the task, and prerequisites for task performance.

Methodology

Two sources of information were used to generate the task descriptions: documentation and discussions with military intelligence Subject Matter Experts (SMEs). The documentation that was examined was as follows:

Classification	Title
Confidential	Software Operators Manual, Application Software Module, Situation Analyst Subsystem, R1 Delivery (U), Jet Propulsion Laboratory, 2 April 1986.
Secret	Preliminary Cost and Training Effectiveness Analysis (U), Volume II (Draft), XMCO, 30 November 1984.

Classification	Title
Confidential	ASAS/ENSCE, R1 User's CDR, Day 1 Narrative Outline (U), Jet Propulsion Laboratory, 1-5 April 1986.
Confidential	ASAS/ENSCE, R1 User's CDR, Day 1 Alphanumeric Displays (U), Jet Propulsion Laboratory, 1-5 April 1986.
Confidential	ASAS/ENSCE, R1 User's CDR, Day 2 Narrative Outline (U), Jet Propulsion Laboratory, 1-5 April 1986.
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Confidential	ASAS/ENSCE, R1 User's CDR, Day 4 Narrative Outline (U), Jet Propulsion Laboratory, 1-5 April 1986.
Confidential	ASAS/ENSCE, R1 User's CDR, Day 4 Alphanumeric Screens (U), Jet Propulsion Laboratory, 1-5 June 1986.
Confidential	Situation Analyst, Functional Area Experts Forum (U), Joint Tactical Fusion Program Office, 14-16 August 1984.
Confidential	All Source Functional Area Experts Forum (U), Joint Tactical Fusion Program Office, 14-16 August 1984.
Confidential	Situation Analyst, Functional Area Experts Forum (U), Joint Tactical Fusion Program Office, 10 January 1985.
Secret	ASAS/ENSCE Functional Area Expert Forum (U), Applications Software Module, Communications Intelligence Subsystem. Jet Propulsion Laboratory, 26 December 1985.
Secret	ELINT, Functional Area Experts Forum (U), Joint Tactical Fusion Program Office, 15 May 1985.
Secret	ELINT II, Functional Area Experts Forum (U), Joint Tactical Fusion Program Office, 27 January 1986.
Secret	ASAS/ENSCE, 1989 System Requirements Review (with Volume II) (U), Jet Propulsion Laboratory, 15-19 September 1986.

Classification	Title
Secret	ASAS/ENSCE, 1989 System Requirements Review, System Security (U), Jet Propulsion Laboratory, 15-19 September 1986.
Secret	ASAS/ENSCE Functional Capabilities Document (U), Jet Propulsion Laboratory, 7 December 1983.
Confidential	ASAS Operational and Organizational Plan (O&O) (U), U.S. Army Intelligence Center and School, 18 July 1986.

The documents were read and initial task description lists were produced. These lists were then submitted for review by SMEs in the military intelligence field. It was found that the SMEs were able to offer input and validation only for tasks that were at a non-detailed functional level since the operational system capabilities and user interface were still being modified by the software engineers. In some cases, detailed tasks could be hypothesized, but the SMEs were not able to attest to the complete accuracy of the tasks.

Lessons Learned

Six problems with the collection of task data during early system development were identified. Two of these problems are discussed concurrently. The other four are discussed as separate topics.

Uncertain Completeness and Accuracy

It was found that during early stages of system development available sources of task data contained information that was either inaccurate or inconsistent between sources. These two problems are both reflections of a single, underlying cause, namely the evolutionary nature of an emerging system. What is true for a system at one point in time may not be true for the system at a later point in development. Documentation produced at different points in time will usually reflect only the current concept of the system. To overcome this problem, training developers must work from current documentation whenever possible, relying on other sources to fill in gaps in the data with a notation indicating the historical placement of this source in relation to more current information. It must also be realized that any task list generated for an emerging system must be seen as correct only within a specified time frame.

Along with inaccurate and inconsistent information, it was found that there were omissions in the data sources concerning tasks that were known to occur in the ASAS/ENSCE releases under examination. It was often the case that one could infer the existence of a set of tasks based on the presence of a menu choice shown in documentation of user

screens. However, the documentation did not indicate the user's tasks after the selection of a menu choice. Thus, the details of these tasks could only be assumed and left for modification during a later iteration of task list development.

Given the available documentation, it was found that in many cases tasks could not be generated to the level specified by the document entitled, A Procedure for Developing Embedded Training Requirements (Roth, et al., 1986). Initially, the intention had been to apply the Embedded Training Requirements (ETRs) selection procedures to the task descriptions generated for this project. However, due to the lack of detailed data, it became apparent that these procedures were not applicable to data generated at an early stage in system development. It is possible that the existing procedures may need some modification in order to successfully produce ET requirements from data that fit one of four categories: functional data, detail-deficient task data, detailed task data, or data composed of a mixture of any or all of the other types.

Lack of SMEs

It also became apparent during this task that one other assumption mentioned in the ETR procedure document could not be met by the task data derived for ASAS/ENSCE. This is the assumption that there are SMEs available to verify the tasks and each task's associated ratings for complexity, criticality, and perishability. In order to have tasks and ratings verified, one needs to have access to an appropriate set of SMEs. An SME, in the context of training development, is someone who is an expert performer of the tasks that are to be verified. In the case of a computer-based system used as an information management tool, an SME should be an individual who is both knowledgeable about the tasks involved with operating the computer system and about the tasks involved in operating within the environment in which the computer system is to be used. As a newly emerging system, ASAS/ENSCE is lacking in personnel who are experts at operating the computer system within the military intelligence environment into which it will be placed.

The ETR procedures do not make allowances for the case in which there is no SME support for task verification. It is imperative that the importance of SME input into the task derivation process during early stages of system development be examined as a research question. The findings of such research can then be used to expand the ETR procedures to account for cases in which SME support is not available.

System Design Coordination

The final lesson learned during the derivation of the ASAS/ENSCE task data concerns the need for schedule correlation, coordination, and interaction between developers of the operating system and developers of ET for that system. Training and system developers need to begin their interactions as early as possible. If there is no coordination

and interaction between these two groups then two problems occur. The first is that without early interaction, training developers have little or no input as to the impact of the expected training requirements upon the development of the system. Training estimates must be made early in order to impact the system design. The current means for making those estimates for ET are unsatisfactory in that the existing ETR procedure assumes data and resources which are not available at the early stages of system development. Thus, training developers need guidelines which will aid them in their assessment of the effect of ETRs on system development.

Second, training development personnel need to have access to all useful material as soon as it becomes available. Coordination of schedules would help alleviate the problem of training developers being the last to receive the newest pertinent information. If the training developers are in step with the system developers, they will be aware of schedule and system changes and will be able to modify their performance likewise. This will increase the efficiency of the training developers by reducing the number of iterations needed to develop ET requirements that are consistent with the system.

To summarize, six problems concerning the collection of early system data were identified. It was found that data often are inaccurate, inconsistent between sources, or missing. Data collected during the early stages of system development often are not at a detailed level and can be expressed only as functional data rather than task data. Also during these early stages, there are often no SMEs to whom one can submit task lists for verification. A final problem is the lack of interaction and schedule coordination between system developers and those responsible for training development. This lack of interaction can affect both the final form of the system and the efficiency with which the training is developed.

EMBEDDED TRAINING REQUIREMENTS SELECTION

Statement of the Task

In the second phase of the project, the requirement was to nominate tasks from the task lists generated in Phase One that should be considered for embedded training. These ETRs had to encompass tasks for acquisition training alone and for both acquisition and sustainment training. To as great an extent possible, task selection was to be made based on the procedures outlined in Roth et al., 1986.

Methodology

The first step that was performed for this phase was a review of the ETR selection procedures appearing in Roth, et al., 1986. Through this review, it was determined that the procedures would need modification. There were four reasons for changing the procedures. First of all, the ETR guidelines are designed to support decisions for tasks that are primarily psychomotor in nature. However, many of the tasks for ASAS/ENSCE are cognitive in nature and the procedures are not applicable as written. The procedures for the selection of ET requirements use the classifications for objectives that rely heavily on examples of psychomotor tasks such as "start turbine engine" and "load and fire howitzer," although the definitions do acknowledge decision skills and rule utilization. It is likely that persons using the guidelines will rely on the examples of the use of the classifications as frequently or more so than on the descriptions of the classifications. It is true that many tasks that are stated in psychomotor terms contain a large cognitive element. Unfortunately, stating the task in psychomotor terms often obscures the importance of the cognitive tasks (or subtasks) that are elements of the overall task. Therefore, to make the guidance for classifying objectives more useful, examples were developed that were obviously cognitive in nature. Second, the procedures for ETR nominations are based on complexity and criticality ratings that require SME validation. However, this validation was absent due to the lack of SMEs. Third, the ancillary data associated with the tasks that were available was not complete enough to allow for some of the more detailed judgments to be made. Fourth, the ETR guidelines are designed for the selection of tasks to be sustained within the unit, rather than those that are to be acquired at the institution or during transition training at the unit. In the case of ASAS/ENSCE, ET is expected to support both acquisition

and sustainment training. Thus the guidelines had to be modified to support both acquisition and sustainment training.

Modification was made by developing definitions and rating scales appropriate to ASAS/ENSCE for the factors of criticality, complexity, perishability, and feasibility. These scales are as follows.

Criticality Scale

High Criticality = 3. Failure to perform this task correctly has a high probability of resulting in significant negative impact on mission success (e.g., intelligence product inaccurate or late in reaching commander, unrecoverable damage to operational database).

Moderate Criticality = 2. Failure to perform this task correctly has some chance of resulting in negative impact on mission success; probability is low, impact is expected to be slight, or error is generally correctable; includes effects on efficiency of information processing or dissemination.

Low Criticality = 1. Failure to perform this task correctly has trivial impact on mission success, or is in all cases correctable with little delay.

NOTE: In Military Intelligence (MI), the essence of mission success is that intelligence information is provided to the commander in a timely fashion. The elements leading up to mission success include acquisition of relevant data, accurate analysis and interpretation of data, and timely dissemination of the resulting intelligence information (to the next stage of analysis or to the command structure). Thus, a critical task is one with a potential to impact the relevance, accuracy, or timeliness of intelligence. All of these factors are situation-dependent; i.e., the items of data which are important, the factors influencing interpretation, and the size of the time window for utilization of intelligence are all variables.

Because of the lack of adequate information to define the situational factors, a worst-case approach to assigning criticality ratings must be used. For example, if an analyst's failure to perform a task correctly would result in a single item of data being lost, it must be assumed that the lost data item could be critical to a specific situation. Similarly, if analyst error could cause a delay, it must be assumed that the delay could be significant in relation to a specific time window. These assumptions almost certainly skew the ratings toward the High Criticality end of the scale. This is only correctable given additional information and SME support.

Complexity Scale

The complexity scale was designed to accommodate the cognitive nature of ASAS/ENSCE tasks. The complexity scale appears in Table 1.

Perishability

As in the ETR procedures presented in Roth, et al., 1986, perishability is directly based on complexity. It is possible that retention of the skill may be independent, or at least partially so, from complexity, such may be the case when a task requires many steps but the system prevents the soldier from deviating from those steps. But for the work discussed in this report, the perishability was defined in terms of complexity as in Roth, et al. (1986). Thus, the following rule was used:

If Complexity = 1, then Perishability = 1

If Complexity = 2 or 3, then Perishability = 2

If Complexity = 4, then Perishability = 3

Note that the highest level of Perishability is 3, which is correlated with the highest level of Complexity which is 4.

Feasibility

The current ETR report (Roth, et al., 1986) presents a flowchart of "implementation" decisions which essentially rate the feasibility of presenting training for each objective. For most of the decisions presented, appropriate data were not available. Thus, this flowchart was replaced with a much simpler set of Yes-or-No questions, as follows:

1. Can the equipment provide the stimuli needed to train the task?

2. Will the provision of embedded training be free from hazard to personnel and equipment?

Certainty Ratings

Each task identified in the task analysis was rated on the above factors. However, the ratings for criticality and complexity were also assigned a "certainty rating" by the project staff members examining the data. The "certainty rating" was assigned in order to reflect the fact that no (or very little) SME input was available to guide the

Table 1

Complexity Scale for ASAS/ENSCE

Code	Title	Description	Examples
1	Basic Cognitive/ Behavior Skill	Basic skills required to operate equipment or perform cognitive task	Read at 8th grade level; recall pass-word; press Enter key
2	Rule or Concept Utilization	Classification or decision-making tasks based on applying concepts or rules to available information in given situations	Determine message routing; identify enemy units; identify high-value targets
3	Sequential Cognitive/ Behavioral Skill	Specific procedures based on basic skills and rule/ concept utilization, and including flexible responses to contingencies and variations in conditions	Edit message text; modify situation map; set alert criteria
4	Complex Inte-grative Cognitive/ Behavioral Performance	Coordinated task performance requiring manipulation of large quantities of data, contingency-based applica-tion of rules in dynamic situations, or rapid inte-gration and synthesis of sensory information	Develop and apply hypotheses about enemy plans; correlate information received from multiple sources; visualize and mentally rotate possible avenues of approach

decisions made concerning task complexity and criticality. The "certainty scale" values were assigned as follows:

1 = Very uncertain of assigned rating; rating is a guess; SME input essential to substantiate.

2 = Moderately certain of rating; educated guess; SME input desirable to validate.

3 = Very certain of assigned rating; based on knowledge of soldier's mission and type of task; SME review preferred but not urgently required.

After values for all of the factors described had been assigned to a task, these rating assignments were examined to determine whether the task should be selected for ET.

Two algorithms for ET nomination were developed; one for acquisition tasks and the other for tasks requiring sustainment. The following rules were used for ET nomination:

1. Answering "No" to either of the feasibility questions would remove it from consideration as an ETR.

2. Nominate objective for acquisition training using ET, unless <u>both</u> Complexity and Criticality equal one (1) (Complexity scale from 4 to 1; Criticality scale from 3 to 1).

3. Objective will be selected for sustainment training if first nominated by rule Number 2 above and Perishability does not equal one (1).

The rule for the nomination of tasks for sustainment training is comparable to the algorithm for task selection that appears in Roth, et al., 1986. The second step, that initially determines whether a task is to be selected for ET at all, is based on the task's criticality and complexity. This rule reflects the notion that critical tasks, regardless of complexity, and complex tasks, regardless of criticality, should be initially taught. The decision that it is not feasible to train the task using ET (rule 1 above) does not rule out the possibility that the task will need to be trained, only that the task is not suitable for ET. The selection of training media for tasks unsuitable for ET was not considered within the context of this project.

It should be noted that although only acquisition and sustainment training are explicitly addressed in the algorithm above, transition training may also need to be considered. In many respects, the needs of a person undergoing transition training should be very similar to someone receiving acquisition training. Therefore it seems reasonable

to assume that rule 2 above should hold for either acquisition or transition training.

Lessons Learned

During the course of preparing ET requirements for the ASAS/ENSCE system, two major lessons learned and two questions for future research were identified. The lessons learned will be addressed initially in this subsection followed by a discussion of issues for further ET research.

Guidelines for Emerging Systems

One of the lessons identified was that the existing guidelines (Roth, et al., 1986) for the nomination of ET requirements are not comprehensive enough for application to all systems for which ET may be appropriate. Specifically, the guidelines, as currently written, are not applicable to systems of the following types:

1. Emerging systems for which there is little or no available SME support.

2. Emerging systems for which there is little or no information available on the ease of ET implementation.

3. Systems that contain many tasks which are cognitive in nature.

4. Systems that will use ET for both sustainment and acquisition training.

The ASAS/ENSCE system is representative of all four of the above mentioned system types. Thus, it was necessary to modify the ETR guidelines to better accommodate the system under examination. These modifications were described in the previous subsection.

Certainty Factors

The second lesson learned came about as a consequence of the lack of SME support available for the ASAS/ENSCE system. Since there was minimal SME input into the task descriptions and their ratings for complexity and criticality, a method had to be devised to indicate task-specific needs for SME review. The ET certainty factors were assigned to the judgments made by project staff for task complexity and criticality in order to indicate to future training developers the need for SME clarification for the ETR decisions made.

Further Research

The lack of SME support for the selection of ET requirements and the means used for compensating for this problem raise two issues which need to be addressed by further research. First of all, the utility of the certainty factors assigned to task complexity and criticality must be ascertained. It is possible that these factors may be useful in actual ET requirement selection. However, research should be conducted to delineate the role of these ratings for decision making.

A second question that should be examined is the actual significance of SME input for the ET requirements selection process. This issue is of vital importance in the case of emerging systems. For emerging systems there are no persons who are experts at the level necessary to inform training recommendations and decisions. In other words, there is no one who is truly knowledgeable in the use of the system as it will be in the field. Nevertheless, recommendations and decisions concerning training development must be made. These recommendations and decisions will rest with persons who will not have access to the type of information specified by the ET guidelines. The question is, then, how accurate are the ET requirements decisions made by training developers without SME support when compared to those that are made based on information supplied by SMEs? An answer to this question will aid in the determination of the extent one may rely on training recommendations and decisions made for emerging systems, especially during their early phases of development.

EMBEDDED TRAINING SYSTEM DESIGN AND INTEGRATION

Statement of the Task

The third phase of the project was the development of ET design and system integration concepts for ASAS/ENSCE. It was expected that the results of this third phase would offer input to the training personnel involved in decision-making processes concerning ET for ASAS/ENSCE. As such, the results of this phase were designed to be as detailed as possible.

The ET design concept needed to include information as to what would be taught, how, and when during the learning process. The integration concept focused on how ET, as a component of a training system, should be integrated with the other components of the system. The integration concept also detailed the way in which ET could be integrated with the operational system.

Methodology For Development of ASAS ET Design

Constraints on ET Design Concept Methodology

It was determined that there were three major factors that constrained the design of ET for ASAS. These were the training needs of JTFPO, the quality of the available task data, and the availability of design decision support by SMEs knowledgeable about various aspects of the system. Each of these factors shaped the final product in significant ways.

Training Needs. JTFPO defined the general characteristics of ASAS training that the training design had to address. The input that was received concerning JTFPO's training needs indicated that ET would be called upon to support the following:

1. Institutional use on operational equipment, simulators, and personal computers (Note: it was clear to JTFPO that the latter two configurations are not ET configurations in the strictest sense).

2. Unit use on operational equipment, possibly with a "strap-on" device to deliver software that will "stimulate" the operational software and thus integrate it with the training database.

3. Training of individuals on non-collective tasks.

4. Training of individuals on collective tasks in both a mode in which input from other individuals is simulated by the system and in a mode in which said input is actually supplied by other individuals through a Local Area Network (LAN).

5. Training for acquisition, transition, and sustainment of job skills.

6. Training that is presented both as tutorials with requisite practice, feedback, and evaluation, and presented in scenario exercises in which feedback and evaluation will be deferred.

Task Data. Another major constraint on the development of the ASAS ET design concept was the quality and veracity of the task data on which the concept is based. Due to the fact that the system under study is an emerging system, any task list developed prior to the actual fielding of the system must be accepted as an approximation to a particular stage in system development. As an emerging system, decisions are still being made as to the capabilities that ASAS will possess. Also, for an emerging system such as ASAS, a task list may be accurate in the elements that it contains, but lacking certain pieces. This problem occurs because many aspects of a soldier's job utilizing the system will not be defined until after fielding of the system and its integration within the unit. For example, as a system for handling data, ASAS may have the capability for the production of paper copies of data. At this point in the development of the system, however, policy has yet to be set that could guide a soldier's decision to produce paper copies of information.

The development of operator tasks for any system requires training developers to have access to current documentation and SMEs. For an emerging system, this approach contains two major pitfalls. First, as the system concept changes, so does the documentation reflecting the state of the system. Thus, training developers must be aware of the currency of their documentation and be prepared to integrate information from new sources into their analyses as it becomes available. Training developers also must establish an effective method for updating the documentation as the operational system evolves. Second, for new systems, quite often there are no SMEs with the appropriate background knowledge to aid in determining the veracity of tasks, the task components, task complexity, and task criticality. The lack of SME "expertness" is especially noticeable when the tasks in question contain a large cognitive element, since documentation rarely indicates the detailed task substeps and the knowledge used for the performance of these types of tasks. It is for these reasons that training analysis and design must be performed in an iterative fashion, so that training developers and decision makers can estimate system requirements for training based on the most valid analysis.

In the case of ASAS, the available documentation allowed for the determination of procedural steps for many tasks, although not to a detailed psychomotor level. However, the details of tasks that were derived from documentation have changed due to subsequent modifications in the system. The substeps that comprise identified cognitive tasks could not be determined and had to be assumed.

These imperfect data were subjected to a procedure to determine ET requirements for ASAS. The procedure used is detailed in Evans, et al. (1987b) and in the previous section of this document.

SME Availability. The final constraint on the design of an ET component is the availability of SME input to aid in decisions concerning the contents of such a component for a system. By "contents" it is meant as such things as the actual data items for the training component tutorials and scenarios, specific wording of all feedback and test items, and detailed information concerning student performance behaviors to be recorded. As stated previously, such support was not available for the ASAS ET design effort.

Concept Development

There are three approaches that one may select from with regard to ET component design for an operational system in an early stage of development. The first option is to wait until the design of the operational system has stabilized prior to initiation of ET component design. This approach is economical in that fewer iterations of the design process are required prior to the development of one that is appropriate to the operational system. The drawback of this approach is that the needs of the training system are considered subsequent to finalization of the operational system, a situation which could lead to a lack of planning for the incorporation of ET into the system.

A second option is to develop a general ET design concept at an early stage in the development of the operational system. This design would address issues for consideration as the operational system is developed. The design would be a framework in which to place detail as it becomes available.

The primary drawback of this second approach is that a general design concept may not include enough detail until its final manifestation to offer input into the development of ET for the system. In this option, constraints resulting from the design of the operational system drive the design of the training, rather than training factors impacting the operational system design in any meaningful way.

A third approach exists that is more resource-consuming than the first two systems, but can supply input to the operational system developers so that they can integrate ET design requirements into the operational system. This third option requires the development of several detailed ET design concepts. This ET concept development would

occur at as early a stage in operational system design as possible. Each ET design concept would be based on all known data concerning the operational system, as well as a set of well-stated assumptions. The variance between designs would be in their assumptions. As details about the operational system become known, the designs may be revised until the one that most resembles the appropriate training system can be determined.

The strength of this third option is that although the training design is modified in response to the changes in the operational system, the designers of the operational system are constantly kept aware of the training design requirements that the operational system must accommodate. It is through this interplay between the needs expressed by the training developers early in the system design cycle and the parameters delineated by the system developers that ET can become truly a part of the operational system.

Documentation Review

In order to develop the ASAS ET design concept, the utility for application of two documents dealing with training design for computer-based systems was investigated. One document was the procedure developed specifically for the production of ET design components (Fitzpatrick, et al., 1987). The other document, An Enhanced Instructional Design Process for Developing Interactive Courseware (Marco, et al., 1986), was focused on computer-based training, in general, and not specifically on ET. Both documents were examined to determine which aspects of the documents were applicable to the development of the ET concept for ASAS.

ET Design Guidelines. Since the task at hand was to develop an ET design concept for ASAS, the first document that was examined speaks directly to the design of ET, the existing guidelines for the design of an ET component (Fitzpatrick, et al., 1987). It is focused on using task objective data to produce a component for ET that contains the training database and details for its implementation. It requires the development of a detailed method for training each ET objective. Therefore, all procedures specified by the report are to be performed on each ET objective. The procedures are divided into six phases. Upon examination of these phases, it was decided that although certain concepts from the first two phases were applicable to the data for ASAS, the later phases required input and produced output at a level of detail that currently cannot be supported by the ASAS data.

The first step in designing an ET component is to review the tasks selected for ET and convert these tasks into training objectives. The first portion of this phase requires the development of a database containing ET requirements to which training priorities have been assigned. This task had been accomplished during Phase Two of the project (selection of ETRs for acquisition and sustainment). The second part of this step is to develop training objectives based upon

the collected task data. It was determined that due to the lack of detailed task information, enabling skills and knowledges for objectives could not be stated. However, it was felt that the tasks themselves could serve as objectives.

In the second step of ET component design, several variables affecting design are identified. These include the following:

1. One or more training approaches.

2. Job-related stimuli.

3. Fidelity needs.

4. Stimulus categories.

5. Performance measures for each objective.

6. Feedback events.

7. Recording events.

8. Stimuli implementation strategies.

For ASAS, it was determined that some of these concepts could be utilized in the design, but possibly not in the form described in the ET design document. For example, a training concept could be devised partially based on the answers to the questions used to identify an approach. However, there was not enough information to identify any job-related stimuli for tasks beyond the equipment in use for the performance of the task. Nor could specific statements concerning performance measures, feedback events, or recording events be made without input from SMEs unless many assumptions were made. For emerging systems, these assumptions should be made, subject to future modification, and documented. It was decided that the concept of fidelity, as stated in the Fitzpatrick, et al. (1987) document, could be amended and applied to the task data in that the basis for fidelity decisions was stated as being task criticality. These types of data, although not verified, were available. The concept of fidelity was expanded, given input from the second document that was examined. ET requirements could also be categorized at a general level in terms of the types of stimuli required. Since both fidelity requirements and necessary stimuli could be identified, task-specific statements concerning stimulus implementation could be made.

It was also felt that guidance for making some decisions required by the ET design document was lacking. For example, the procedure for selecting feedback presents definitions for different types of feedback without mentioning how to select between these different types.

Marco, et al., Document. The second document that was found relevant for this effort (Marco, et al., 1986) gives guidance in the

development of training design concepts for interactive computer-based courseware, as would be developed for an ET application. Although this document does not specifically address the issue of design for ET, it was felt that many of the concepts and the approach described by Marco and her colleagues were extremely applicable to the development of an ET design concept to be based on partial data.

Marco's approach developed out of need to produce Computer-Based Training (CBT) for the Model Training Program for Reserve Component Units (MTP-RC). She and her colleagues identified weaknesses in existing guidelines for producing CBT. These weaknesses included such problems as an inefficient approach that iterates the same design steps over many lessons, little guidance for making design decisions, and no conceptual tools given for designing non-linear media. Thus, the objectives of their document were threefold. First, Marco and her team wanted to define a way in which similar tasks could be identified and grouped so as to be able to create instructional designs that can be applied to lessons in which similar skills are taught. Second, the team aimed at developing guidance for making design decisions concerning various training variables, including decisions on mastery training, feedback, and learner control of lesson presentation. The third objective of the Marco team was to provide design tools and techniques that would separate the lesson content from program logic. It is the first two objectives of the Marco group which were addressed in the ASAS situation. The third objective was of interest, but it was felt that within the context of this project, the information and resources necessary to develop tools for program logic were not available and thus this objective was not pursued.

The first step in the process developed by Marco, et al. (1986) is the selection of the task content for the training. According to the Marco group, there are four factors that affect content selection. These are institution, audience, content variables, and resources available for training development. One must assess the effect on content selection by answering training-relevant questions for each factor in turn. Typical issues that might be addressed include:

Institution: Training location
Training frequency
Mode of training delivery
Factors leading to the development of training at this time

Audience: Composition of the audience
Current level of expertise of the audience
Length of time at current level of expertise
Level of motivation for learning
Level of familiarity with the training medium

Content: Task criticality
Task stability or perishability
Frequency of need to perform task
Task transferability

Resources: Time available for training development
Time availability for training
Budgetary constraints
SMEs available for training development and their cost

In the case of ASAS, content for training was developed by the application of procedures for the selection of ET requirements described in Evans, et al., (1987b) and in this report. It is useful, however, to examine the effect on content selection for ASAS training that occurs when one looks at the issues identified by Marco, et al., as related to content decisions for ASAS ET. For example, it is known that ASAS ET is to be delivered at both the institution and the unit, thus tasks for either or both acquisition and sustainment training must be identified. The frequency of delivery will vary given that the training will serve more than one function. The audience for computer-based training will consist of military intelligence analysts of various MOSs and skill levels. These students will already be versed in MI analysis using manual procedures, but they may not be at all familiar with computer systems such as ASAS. The audience will also consist of maintenance personnel and others performing non-analyst duties. Since training will be for several levels and types of personnel, the training should reflect the differences in MOSs and skill levels. The initial training also should be aimed at computer novices. On the other hand, detailed knowledge concerning content issues is uncertain; the frequency of task performance is unknown, as is skill and knowledge transferability from the manual mode to the automated; and knowledge concerning task criticality, complexity, and perishability is shaky. Thus it is necessary to select tasks for training rather than to reject them until clarification on these issues can be obtained. With regard to the final factor, availability of resources for training development, resources will constrain the tasks eventually selected for training development and implementation, but the audience resources should not impact upon the identification of tasks requiring training nor the methods by which these tasks should, ideally, be trained.

Given the knowledge available on these issues identified by Marco and her colleagues as being important for the determination of training content, the comparison of the tasks that might be selected for training using the Marco strategy and those selected by the modified ET requirements procedure used at an earlier stage in this project, would probably result in the development of very similar lists of tasks to be trained. However, such an overlap might not occur for systems for which the current ET requirements guidelines are applicable. The correlation between findings using the Marco procedure, the modified ET procedure, and the current ET requirements guidelines should be investigated empirically to determine if the results of early procedures are acceptably predictive of later system training needs.

After determining the content of training, Marco and her colleagues perform a training task analysis that results in training objectives and their enabling skills and knowledges. They identify commonalities between skills and knowledges and cluster the skills and knowledges into groups that represent the selected dimensions.

As mentioned previously, the tasks selected for ET were used as the training objectives. However, after examining the ASAS ET requirements, at least three ways were identified in which to group tasks. One way focused on the commonalities between soldier-machine interface tasks that appear for all functional areas, to greater and lesser extent. This approach produced the following groups: file management tasks, database management tasks, message production tasks (word processing), and graphics production tasks. These task groups appear as both CU tasks and within MI problem solving contexts for the functional areas. For example, all personnel perform some types of database management tasks, such as information retrieval, but personnel in some of the functional areas will be required to perform more complex database management tasks (e.g., information correlation) than other personnel. Another clustering of tasks consisted of overt behavioral procedures versus cognitive procedures. The third grouping of tasks was the separation of the CU tasks, which appear in all function-specific contexts, and the functional area tasks (CM, SS, AS, TA, SA, ELINT, COMINT). It was felt the best way to handle both the commonalities between tasks and the differences was to discuss training in terms of task types and ET training structure (Tiers). The first part would address the training design for the overall task groups mentioned above. The second half of the design concept would focus on task-specific issues for tasks drawn from each functional area.

Marco, et al., identified several variables on which to base their training design. These variables are feedback level, learner control, passing level, simulation fidelity, performance error fidelity, and level of guidance. They also developed guidance for making decisions for these variables that could apply to one or to a group of similar tasks. These decisions concerning the training variables were used to develop templates for training groups of skills and knowledges.

The variables identified by Marco and her colleagues were examined and those that seemed the most applicable to the ASAS situation were selected. These variables were passing levels, learner control, feedback, and simulation fidelity. The definitions for feedback and simulation fidelity were modified to be more reflective of the concepts as represented by the ET design document. Marco's concept of level of guidance also was selected but renamed "decision cueing" to better reflect the actual process. Marco's definitions for these variables are as follows:

Passing Levels: " ... the description of the acceptable performance level. It is the measure of the soldier's mastery of the criterion of the instructional objective." (p. 21)

Learner Control: "... the degree to which the learner or the computer program controls the learner's path through the sequence of units, lessons, or segments of instruction. Learner control also refers to who or what controls the selection of which content to learn within a unit, lesson, or segment of instruction." (p. 21)

Feedback: "... the procedure used to tell a learner if his response to an instructional event, usually a practice item or test question, is right or wrong." (p. 20)

Simulation Fidelity: "... the degree of similarity between the stimuli and actions taken during training and the stimuli and actions taken during the actual performance of the task." (p. 22)

Level of Guidance: (Decision Cueing) "... is concerned with the amount of guidance in the form of textual prompts and visual cues that should be included in a lesson." (p. 24)

It was felt that the variables selected from the Marco, et al., paper required augmentation and modification to make them more specific to ASAS. In addition, two factors were added to the list discussed in the paragraph above. The first of these factors was "relationship of manual intelligence procedures to ASAS procedures." Since the MI students learning how to use ASAS will have received previous instruction on the performance of MI tasks in a manual mode, there should be some transfer from the concepts learned manually to their implementation using ASAS. This relationship can be used to promote efficient learning by indicating to the student the similarities and differences between the manual performance of t task and the ASAS version. Also, such transfer means the ASAS training will not have to address the non-ASAS aspects of the tasks in-depth. For these reasons, it was felt that it would be informative to address the transfer issue for all ASAS tasks to which it pertains.

The second variable that was added to the design variables list was a factor indicating the need for demonstrations of procedures that are performed using ASAS. These demonstrations would be dynamic and would simulate operator behavior. It was felt that this factor would be useful for the determination of the training approach for both individual tasks and for groups of common tasks.

Definitions of Variables Selected

After the examination of the documentation, two lists of variables were arrived at for inclusion in the design concept. One list was selected for use in the general training design concept and the other was selected for the task-specific comments. The difference between the two lists is that the variable of learner control is omitted from the task-specific list. This omission is due to the inability of arriving at any statements concerning learner control that did not apply to all tasks. The variables are as follows:

General	Task-Specific
Passing Levels	Passing Levels
Relationship of Manual Intelligence Procedures to ASAS Procedures	Relationship of Manual Intelligence Procedures to ASAS Procedures
Procedure Demonstrations	Procedure Demonstrations
Learner Control	Feedback
Feedback	Decision Cueing
Decision Cueing	Simulation Fidelity
Simulation Fidelity	

These variables are defined as follows.

Passing Levels. The acceptable performance level prescribed by TRADOC to be achieved by the individual trainee. Passing levels include any of the following:

1. Complete Mastery - All tasks are performed without error. Complete mastery is recommended for tasks and skills which are identified as critical, or if errors could result in injury, loss of life, or damage to equipment. Complete mastery also applies to subtasks that are prerequisite to a critical task. Complete mastery requires not less than a 100 percent passing level.

2. Partial Mastery - Trainee performance is required to be at a high level, but complete mastery of tasks and subtasks (non-critical only) is not required. Partial mastery is appropriate during practice and instructional setments of the training period. Percentage passing levels (i.e., 80 percent) will be determined by TRADOC.

3. No Mastery (familiarization) - Individual trainee performance is not measured. No mastery is intended to provide the trainee with general knowledge and information only.

Relationship of Manual Intelligence Procedures to ASAS Procedures. Acquisition training at institutional and unit levels will consist of initial learning of manual techniques for intelligence gathering and processing. This will be followed by training to use ASAS/ENSCE tools to perform these same tasks. Numerous relationships exist between present manual procedures and those envisioned to be performed by ASAS/ENSCE. For example, ASAS/ENSCE graphic capabilities provide an automated means of performing those tasks that must be done manually with a map and paper overlays. These relationships must be pointed out because much of the skills and knowledge associated with map reading will be taught during student manual procedure training and need not be addressed in detail during ASAS/ENSCE ET.

Procedure Demonstrations. Procedure demonstrations where the training software simulates correct operator interactions with the system would be particularly appropriate for simple soldier-machine interface activities such as system initialization, message access, template completions, etc. Higher level interactions such as overlay generation, mission planning, file modifications, etc., are also appropriate for demonstrations of proper procedure.

Learner Control. Learner control refers to the amount and type of control that a student may have over his interaction with a training system. This control can be either in the sequencing of training or in the initiating or terminating of training or both. He may also be allowed to choose a difficulty level.

Feedback. Feedback involves providing information to the trainee about his performance on a learning activity, such as a practice item or test question. Two primary aspects to be considered when specifying feedback requirements for training are: 1) immediacy of the feedback, and 2) comprehensiveness of feedback given. A third aspect is feedback adaptivity.

Decision Cueing. MI gathering and processing via manual means is assumed known. However, with the arrival of ASAS/ENSCE, it cannot be assumed that soldiers in the MI community are computer literate and possess adequate typing skills to function reasonably well within the ASAS/ENSCE environment. Therefore, it must be assumed the trainees' system knowledge and experience is nil.

Under these conditions, the level of system-based guidance (cueing) must be high for at least the initial stages of the training course. As the trainee advances through the course, knowledge and experience, hopefully, increases. Thus, it can be assumed the trainee will become less and less dependent upon cues. Of course, cues or prompts should be avoided for the purpose of quizzing or tests. Scenarios should also be free of cueing when presented at or

near the terminal point in the training course. Conversely, any scenarios presented during the earlier stages in the course probably should contain appropriate cues.

Simulation Fidelity. Initial training might require high fidelity simulation, but in less than real time. High fidelity simulation creates an enhanced learning environment and the less than real-time running speed allows for transfer of course objectives to the trainee. High fidelity simulation should also be considered for tasks and subtasks which are identified as critical or hazardous.

Theater-specific scenarios should be of high fidelity, without question or debate. Simulations of lower fidelity are appropriate for lower level tasks and sub-tasks and also where a long chain of procedural steps contain routine or repetitive processes.

Development of Additional Guidance

In the Marco, et al. document (1986), guidance is provided for making decisions concerning the application of the variables discussed in their paper. That guidance was used in applying the specially selected Marco, et al. variables to the ASAS tasks. Additional guidance was developed for use in the application of the variables generated specifically for ASAS (these variables were "relationship of manual intelligence procedures to ASAS procedures" and "procedure demonstrations").

Analysis of Tasks

Stable ASAS tasks were then analyzed with respect to the sets of variables and guidance described above. A task was defined as stable if it appeared consistently in different sources of documentation (e.g., Functional Area Expert Forum and Critical Design Review documents) or an SME provided verification of the task. This definition eliminated many of the operator tasks that were impacted by system-user interface design changes (such as: menu choice selection and input device used) that occurred during the time frame of this project. The outcome of the task analysis was a task-by-task discussion of training recommendations and a more general set of recommendations. The general design concept was the distillation and summary of common findings across all of the tasks that were examined. The discussion within both the general design concept for ASAS and the task-specific comments is in terms of the training needs of JTFPO, identified task groupings, and the Tiers in which tasks would be trained as they pertain to the task(s). These are as follows:

1. Training type: Acquisition or sustainment or both

2. Training location: Institution or unit or both

3. Training audience: Individual or collective or both

4. Task group: Files management, database management, text production, or graphics production; overt behavioral procedures or cognitive procedures; CU or functional areas

5. Training approach: Tutorial or scenario or both

6. ASAS release schedule: Early or later, and integration

Tier I — Teaches common user tasks, such as word processing, log-on and log-off, etc. It also presents an overview of the training program and explains how to interface with ET. An overview of ASAS/ENSCE is also presented. Generally uses tutorials as training approach.

Tier II — Teaches ASAS/ENSCE function-specific tasks in an MI context. Topics to be included are symbology, message traffic, and security policies and procedures, as well as functional area tasks. Generally uses tutorials as training approach.

Tier III — Deals with mission training. Includes Red/White/Blue scenarios as well as enclave specific scenarios. Generally uses scenarios as training approach. The scenarios are both static and dynamic.

Tier IV — Presents complex, theatre-specific scenarios. Uses free-play scenarios as training approach.

Methodology for Development of ASAS ET Integration Concept

As mentioned previously, the concept for integrating ASAS/ENSCE ET needed to reflect two types of integration: first with the other components of the training system and, second, with the operational system. The first integration task required an examination of ways in which tasks similar to those selected for ASAS/ENSCE may be trained: instructor-led, hands-on, computer-based self-paced instruction, etc. Tasks that were nominated for ET may be presented using other media. The question is, "How much of the training for a task is to be trained using the operational system (ET), on stand-alone devices using computer-based instruction (CBI), or instructors giving presentations?

In order to answer the question stated above, current training plans for ASAS/ENSCE were examined. These plans presented course-length estimates based on Plans of Instruction (POIs) for existing MI courses. These estimates were combined with estimates of course size

made by examining the tasks to be trained and their complexity. These estimates produced approximations of the numbers of lessons to be taught.

A second approach was used, also. First, tasks were grouped as described in the previous subsection. These groupings included:

1. Common user tasks--file management, word processing, situation display, database management, security, message reception and transmission.

2. Functional area tasks--CM, TA, AS, SA, SS, COMINT, ELINT.

3. Cognitive tasks--decisions, analyses, etc.

4. Psychomotor tasks--data input using alphanumeric keyboard, moving cursor control or device, etc.

For each identified category of tasks and its subcategories, possible methods of instruction were identified. These methods of instruction were examined in terms of type of task, its complexity, and whether the task(s) could be demonstrated via a computer. Approaches for training categories of tasks and individual tasks were developed. These approaches included discussions of the types of media to be used to train types of tasks and how the media interrelate. Definitive approaches, however, could not be determined, only suggestions for alternatives based on different sets of assumptions.

The procedure used for determining the second type of integration concept (ET and operational system integration) was simple. Various draft documents addressing general ET requirements were examined in light of ASAS/ENSCE needs. A market survey of CBT products applicable to ASAS/ENSCE was also examined. The information presented in the accessed sources was utilized to define issues for discussion and to aid in the development of alternatives for ET-operational system integration.

Lessons Learned

Several lessons were learned during the process of developing the ET design and integration concepts presented in the third document produced for this project. These lessons also suggest areas for further research on the topic of ET design development and recommendations for guidelines for design.

ASAS ET Design

There were two important lessons that resulted from the development of the ET design for ASAS/ENSCE. First of all, it was determined that the existing ET guidelines for design development are not appropriate for the type of data that were available for ASAS. The procedures set forth in Fitzpatrick, et al. (1987) are geared for systems whose operational design and policy issues concerning utilization have been resolved. This focus assumes that the collected data are stable, at a detailed behavioral level, and verified. This situation does not exist for ASAS/ENSCE. The data collected for ASAS/ENSCE, although the best available at the time, are neither stable, at the correct level of detail, nor necessarily correct. In addition, the procedures produce a design concept that is at a very detailed level. During an early ET design iteration for an emerging system, one must make assumptions about the system and the training requirements for that system in order to develop an ET design concept. As information becomes available the design must be revised.

The existing guidelines also assume that there will be or has been SME input available for various training decisions that must be made, such as performance measure selection. Prior to system stabilization, this type of input may not be available, and was not available for this particular system. Again, one may make assumptions and base the design on those assumptions, with the understanding that the design will require future modification.

To deal with these problems for production of an ET design component, a concept to ET system design was developed based on known information and certain stated assumptions. This design indicated issues of importance for training and recommendations for consideration during the development of ET for ASAS/ENSCE tasks. It is foreseen that at some later point in time a revised design will be developed.

During the examination of the ET design guidelines, a deficiency was identified in those procedures that render them difficult to use. The problem is that certain procedures define the elements in question but do not explicitly give guidance for making decisions concerning the elements. A case in point is the discussion on the selection of the type of feedback to use in training an objective. Several types of feedback are defined, but no rules for selection are supplied. To overcome this problem, a document was used that, although not ET specific, offered the type of guidance that was sought. This document, An Enhanced Instructional Design Process for Developing Interactive Courseware (Marco, et al., 1986), also supplied a framework with which to approach the problem of developing an ET design concept for ASAS.

Given these lessons learned, several recommendations for the ET design guidelines can be suggested. First, for an emerging system such as ASAS/ENSCE, a design concept should be developed that is as detailed

as possible as early as possible, touching on all issues that pertain to the ET component of a training system. In cases in which information is lacking, assumptions, which are clearly labeled as such, may be made in order to produce a complete concept. A revised package should be developed as soon as there are data to support such an effort. The design concept should contain a discussion of the training issues which will be addressed and augmented in future revisions. This initial design concept would give guidance for decision making with regard to the contents of training when ET is actually produced. The variables and issues that are addressed in the design concept should reflect those that appear in the existing ET design documents, but could be supplemented by others that are selected from similar documentation or which can be supported in some way.

A second recommendation for the development of ET design guidelines concerns the state of explication in the current procedures. The guidelines require expansion in the guidance they supply for decision making concerning the selection of values or contents for training variables.

ASAS ET Integration

The task of developing an ET integration concept for ASAS resulted in two lessons. First, it was found that due to the lack of system stability, it was impossible to develop a detailed integration concept for ASAS ET without making assumptions about the operational system. The major difficulty that arose was that the system interface is still being modified. However, statements concerning integration were made based on available information and assumptions.

The second difficulty that was experienced during the development of the integration concept was a lack of detailed knowledge concerning the operational software for the system. Without that information, it was difficult to pinpoint the specific "hooks" between the training software to be developed and the operational software. By "hooks" it is meant both specific interface components, at the level of individual screens and input data required of the learner, and the aspects of the computer code that allows for the training software to stimulate the operational software. Although one can suggest alternative ways for the training and operational software to interact, these "hooks" can really only be specified if the form of all potential user-system interactions is known and if the operational software is understood at a detailed level. For example, in order to train a user on word processing capabilities of a system, one must know the format of data presented on the screen, the available commands, the alternatives for entering commands, the results of those behavioral alternatives and the input commands, typical contexts for text processing, and the way in which one can integrate the text processing software code with the training software code. In the case of ASAS/ENSCE, however, very little of the information available was at the level appropriate for determining specific "hooks." This constraint limited the type of

integration information that could be produced. Therefore only the categories of operational software to be stimulated and their contexts for stimulation were discussed.

Summary for ET Design and Integration

Thus for an emerging system, ET design and integration concepts must be based on a combination of fact and informed fiction. Initially, the design and integration concepts should be very detailed, but primarily based on assumptions. In fact, it might be useful to generate multiple sets of concepts, each one based on a particular set of well-defined assumptions. As details of the operational system become available, the ET component concepts can be revised to reflect these changes, moving the concepts from the fiction end of the continuum to the "all fact" end.

CONCLUSIONS

Through all phases of the project, two problems stand out. Each of these problems affects the way in which one approaches training design for emerging systems.

First of all, for an emerging system such as ASAS/ENSCE, there are very few, if any, SMEs available to offer input into the training development process. This lack of SME support is especially true in the case of tasks with a large cognitive component.

A second problem encountered during all phases of this project was the fluctuating nature of the system during the development phase. These fluctuations resulted in documentation that was both incomplete and invalid in its details.

These two problems may be overcome by the use of two procedures. The utilization of these procedures will not necessarily produce a completely valid design for ET at an early stage in operational development, but will lay the groundwork for the generation of a valid ET component design at some later time.

During early stages of the development of the operational system, an ET design should be developed that is based on a combination of available data and assumptions that "flesh out" the existing information. As new data become available, the design should be modified to incorporate them. Another alternative is to develop a set of ET design concepts, each based on a different set of assumptions in combination with verified data. As the operational system develops, the design concept that is closest to the factual situation would be the one selected for modification and use for the future iterations.

A second procedure that seems to offer utility in the development of an ET design is the flagging of unvalidated information. For this project, the flagging procedure consisted of the assignment of certainty ratings to values for complexity and criticality for each task. Assigning an indicator of certainty allows one to differentiate between uninformed assumptions, valid data, and those partially informed "guesses" or assumptions that fall somewhere in the middle of the continuum between the two extremes.

Finally, the thread of thought that connects the two previous ideas, the design of the ET component of a training system must be viewed as an iterative process. As the data are made available, task lists, ETRs, and the ET component design all must be updated. The ET component design is also affected by operational system hardware and software constraints, and by parameters imposed by others involved in the development of the operational system and the training for that

system. The best way to ensure that the designers of the operational system will take into account the software and hardware requirements of the ET system is for the training developers to produce a detailed training design that includes ET estimates at the earliest point as possible in operational system development. Such estimates will give the developers of the operational system some basis for making design judgments that will affect the incorporation of ET into the operational system.

REFERENCES

CONFIDENTIAL Joint Tactical Fusion Program Office. (14-16 August 1984). All Source Functional Area Experts Forum (U).

CONFIDENTIAL U.S. Army Intelligence Center and School. (18 July 1986). ASAS Operational and Organizational Plan (O&O) (U).

CONFIDENTIAL Jet Propulsion Laboratory. (7 December 1983). ASAS/ENSCE functional capabilities document (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 1 Alphanumeric Displays (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 2 Alphanumeric Screens (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 3 Alphanumeric Screens (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 4 Alphanumeric Screens (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 2 Graphic Displays (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 1 Narrative Outline (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 2 Narrative Outline (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 3 Narrative Outline (U).

CONFIDENTIAL Jet Propulsion Laboratory. (1-5 April 1986). ASAS/ENSCE, R1 User's CDR, Day 4 Narrative Outline (U).

SECRET Jet Propulsion Laboratory. (15-29 September 1986). ASAS/ENSCE, 1989 System Requirements Review (with Volume II) (U).

SECRET Jet Propulsion Laboratory. (15-29 September 1986). ASAS/ENSCE, 1989 System Requirements Review, System Security (U).

SECRET Joint Tactical Fusion Program Office. (15 May 1985). ELINT, Functional Area Experts Forum (U).

SECRET Joint Tactical Fusion Program Office. (27 January 1986). ELINT II, Functional Area Experts Forum (U).

SECRET Evans, D. C., Fitzpatrick, J. A., Adams, J. E., Aldrich, R., Dyer, F., & Narva, M. (1987a). Preliminary task descriptions for ASAS/ENSCE. (ARI Working Paper). Butler, PA: Applied Science Associates, Inc.

SECRET Evans, D. C., Fitzpatrick, J. A., Adams, J. E., Aldrich, R., Dyer, F., & Narva, M. (1987b). Preliminary embedded training requirements (ETRs) for ASAS/ENSCE. (ARI Working Paper). Butler, PA: Applied Science Associates, Inc.

SECRET Evans, D. C., Adams, J. E., Simkins, M. L., Fitzpatrick, J. A., Aldrich, R., Dyer, F., & Narva, M. (1987c). Preliminary embedded training design and integration concepts for ASAS/ENSCE. (ARI Research Product). Butler, PA: Applied Science Associates, Inc. (In Process)

UNCLASSIFIED Fitzpatrick, J. A., Warm, R. E., Ditzian, J. L., & Roth, J. T. (1987). Interim procedures for embedded training (ET) component design. (ARI Research Product). Butler, PA: Applied Science Associates, Inc. (In Process)

UNCLASSIFIED Marco, R. A., Begg, J., Israelite, L., & Bernstein, K. (1986). An enhanced instructional design process for developing interactive courseware. (ARI Technical Report 713).(AD A177 532)

SECRET XMCO. (30 November 1984). Preliminary cost and training effectiveness analysis, Volume II (Draft).

UNCLASSIFIED Roth, J. T., Sullivan, G. K., & Ditzian, J. L. (1986). A procedure for developing embedded training requirements. (ARI Working Paper). Butler, PA: Applied Science Associates, Inc.

CONFIDENTIAL Joint Tactical Fusion Program Office. (14-16 August 1984). Situation Analyst, Functional Area Experts Forum (U).

CONFIDENTIAL Joint Tactical Fusion Program Office. (10 January 1985). Situation Analyst, Functional Area Experts Forum (U).

SECRET Jet Propulsion Laboratory. (26 December 1985). ASAS/ENSCE Functional Area Expert Forum, Application Software Module, COMINT Subsystem (U).

CONFIDENTIAL Jet Propulsion Laboratory. (2 April 1986). Software Operators Manual, Application Software Module, Situation Analyst Subsystem, R1 Delivery.

CONFIDENTIAL Jet Propulsion Laboratory. (2 April 1986). Software Operators Manual, Application Software Module, Situation Analyst Subsystem, R1 Delivery (U).